2009 SUMMARY REPORT
of
Lake NaPaSuWe

Lake County, Illinois

Prepared by the

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EXECUTIVE SUMMARY

Lake NaPaSuWe is an 85-acre shallow slough in southwestern Lake County. It is located within the Fox River watershed, in Wauconda and unincorporated Lake County, northwest of Fairfield Road and Bonner Road. Lake NaPaSuWe receives water from Ozaukee Lake (Drummond Lake). Water exits the lake by way of a spillway located at the northwest portion of the lake and empties into Mutton Creek, eventually flowing into the Fox River. Various stormwater inlets enter the lake from surrounding residential areas. Residential lots surround much of the lake except for two parks owned by the Orchard Hills Homeowners Association and the Apple Country Homeowners Association. Lake NaPaSuWe residents use the lake for aesthetics, fishing and non motorized boating.

The lake was assessed for various water quality parameters from May-September, 2009 at the inlet and the outlet. Water clarity in the lake was below the county median of 3.15 feet, with an average Secchi depth of 2.25 feet. Since the 2002 sampling season the Secchi depth has increased more than a foot from 0.98 feet. The 2009 total suspended solids (TSS) concentration was 12.1 mg/L and decreased over 70% from the 2002 average of 43.4 mg/L at the inlet and the 2009 outlet concentration of 26.4 mg/L was a 56% reduction from the 2002 value of 60.4 mg/L. This decrease in TSS correlates to the increase in Secchi transparency. In Lake NaPaSuWe, the 2009 average conductivity was 0.6644 mS/cm at the inlet which was a 32% decrease from the 2002 value of 0.9750 mS/cm and the 2009 outlet concentration (0.6390 mS/cm) decreased 56% from the 2002 concentration (0.9609 mS/cm).

Nitrogen and phosphorus are the two nutrients that can limit plant and algal growth. The 2009 average epilimnetic total phosphorus concentration in Lake NaPaSuWe was 0.069 mg/L at the inlet and 0.057 mg/L at the outlet, these values were close to the county median of 0.063 mg/L, but a 69% and 75% decrease from the 2002 TP concentrations of 0.203 mg/L and 0.230 mg/L respectively. The 2009 average total Kjeldahl nitrogen concentration was 1.46 mg/L at the inlet and 3.50 mg/L at the outlet which was a 49% and 63% decrease from the 2002 concentrations of 2.85 mg/L and 3.50 mg/L respectively.

The aquatic plant community in the lake consisted of seven species in July. Coontail, Eurasian Watermilfoil and Watermeal were the dominant species, Duckweed was common, and Star Duckweed, Sago Pondweed, and Curlyleaf Pondweed were also present. Plant diversity decreased since 2002. Common Bladderwort and Flatstem Pondweed were not found in 2009. Aquatic plant density increased from 2002 to 2009 with 99% of sites on Lake NaPaSuwe with plants.

The shoreline was reassessed in 2009 for changes in erosion since 2002. Based on the 2009 assessment, there was a significant increase in shoreline erosion from 14% to 23% of the shoreline having some degree of erosion. Overall, 18% of the shoreline had slight erosion, 4% had moderate erosion, and 1% had severe erosion.

LAKE FACTS

Lake Name:	Lake NaPaSuWe
Historical Name:	Breeden Slough/Mutton Lake
Nearest Municipality:	Wauconda/Fremont
Location:	T44N, R9/10E, S13, 18, 19, 24
Elevation:	789.8 feet mean sea level
Major Tributaries:	Ozaukee Lake
Watershed:	Fox River
Sub-watershed:	Mutton Creek
Receiving Waterbody:	Mutton Creek
Surface Area:	85.3 acres
Shoreline Length:	4.6 miles
Maximum Depth:	3.5 feet
Average Depth:	1.4 feet
Lake Volume:	126.2 acre-feet
Lake Type:	Impoundment
Watershed Area:	665.7 acres
Major Watershed Land Uses:	Single family, and Private and Public Open Land
Bottom Ownership:	Private
Management Entities:	Lake NaPaSuWe Association
Current and Historical Uses:	Aesthetics, fishing, non-motorized boating
Description of Access:	Private

SUMMARY OF WATER QUALITY

Water samples were taken monthly May through September from the inlet and outlet of the lake. Surface samples were collected at the outlet on the north side of the lake from the dam structure. The inlet samples were collected from the main body of the lake on the south end of the lake at the 3 foot depth when plant densities allowed in May and July and at the surface June, August, and September (Figure 1). Both locations were sampled and analyzed for various water quality parameters (Appendix A). Lake NaPaSuWe is within the Mutton Creek watershed within which the LMU sampled one other lake, Ozaukee Lake. Ozaukee Lake drains west under Fairfield Road into Lake Napa Suwe that is connected to a tributary to Mutton Creek and eventually flows into the Fox River. Other lakes in the Mutton Creek watershed include Lake Fairfield and Island Lake.

In 2002 Lake NaPaSuWe's water quality was considered poor with many parameters well above Lake County medians. In 2009, the water quality had significantly improved, as shown by some water quality parameters near or below county medians. The total suspended solid (TSS) concentrations averaged 12.1 mg/L for the inlet and 26.4 for the outlet (Table 1), which is considerably higher than the county median of 7.9 mg/L (Appendix E). These TSS values are considerably lower than the 2002 values; the inlet was 72% lower (43.4 mg/L) and the outlet was 56% lower (60.4 mg/L). High TSS values are typically correlated with poor water clarity and can be detrimental to many aspects of the lake ecosystem such as the aquatic plant and fish communities (Figure 2). TSS is composed of nonvolatile suspended solids (NVSS), non-organic clay or sediment materials, and volatile suspended solids (TVS), algae and other organic matter. The outlet TSS value was significantly higher than the inlet. A major contributing factor influencing the difference in values is the excessive Common Carp population within the lake. Common Carp feeding behavior causes resuspension of sediment and nutrients that can lead to increased turbidity. Calculated nonvolatile suspended solids (NVSS) was 22.9 mg/L at the outlet. This means that 87% of the TSS concentration is related to suspended inorganic particles. The other 13% can be attributed to organic particles. The 2002 NVSS value of 42.3 mg/L was 71% of the TSS. The 2002 and 2009 NVSS values indicate that the major impairment for water clarity was from inorganic suspended particles such as sediment. However at these high concentrations the 13% of organic particles was significant. The 2002 Lake NaPaSuWe assessment documented constant algae blooms throughout the lake and a near absent aquatic plant community. The 2009 lake assessment also noted frequent algal blooms; however the severity of the events was less. This could be documented by the reduction in TVS in Lake NaPaSuWe from 2002 when the values at the inlet and outlet were 201 mg/L and 198 mg/L, respectively when compared to the 2009 values that are nearly half at 98 mg/L at the inlet and 105 mg/L at the outlet.

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Secchi disk transparency is an indicator of overall water quality. In general, the greater the Secchi disk depth, the clearer the water and better the water quality. The median for Lake County lakes was 3.15 feet. Based on Secchi depth, Lake NaPaSuWe has below average water quality. The 2009 average Secchi disk depth was 2.25 feet from May to August was a 130% increase from the 2002 average of 0.98 feet. The monthly readings varied from 3.60 feet in August to 1.48 feet in June. The September Secchi disk reading was obscured by plants so an accurate reading could not be taken. Lake NaPaSuWe has participated in the Illinois

Figure 1. Water quality sampling site on Lake NaPaSuWe, 2009.

Table 1. Water quality data for Lake NaPaSuWe Inlet, 2002 and 2009.

2009	Inlet															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
12-May	3	187	1.58	<0.1	<0.05	0.103	<0.005	NA	102	16.0	460	99	1.87	0.7460	9.29	7.85
9-Jun	0	152	1.68	<0.1	<0.05	0.095	<0.005	NA	107	18.0	440	108	1.48	0.6920	8.90	8.47
14-Jul	3	132	1.55	<0.1	<0.05	0.075	0.006	NA	105	12.0	392	101	2.03	0.6300	9.13	7.27
11-Aug	0	120	1.25	<0.1	<0.05	0.041	<0.005	NA	105	9.4	373	91	3.60	0.6130	9.29	8.11
15-Sep	0	135	1.24	<0.1	<0.05	0.029	<0.005	NA	107	5.1	393	92	NA	0.6410	8.97	6.83
	Average	145	1.46	<0.1	<0.05	0.069	0.006[k]	NA	105	12.1	412	98	2.25	0.6644	9.12	7.71

2002	Inlet															
DATE	DEPTH	ALK	TKN	NH3-N	NO3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
30-Apr	3	266	2.28	<0.1	<0.05	0.165	<0.005	632	NA	31.0	667	205	1.39	1.0300	8.19	9.29
5-Jun	3	239	2.95	<0.1	<0.05	0.195	<0.005	640	NA	42.2	653	187	1.05	0.9523	7.81	4.96
9-Jul	0	233	1.23	<0.1	<0.05	0.206	0.006	612	NA	45.0	655	193	0.79	0.9936	8.31	6.07
6-Aug	0	207	4.62	<0.1	<0.05	0.267	0.008	607	NA	69.0	692	222	0.85	1.0090	8.45	6.06
4-Sep	0	192	3.15	0.242	<0.05	0.184	<0.005	516	NA	30.0	596	198	0.82	0.8902	8.13	7.35
	Average	227	2.85	0.242[k]	<0.05[k]	0.203	0.007[k]	601	NA	43.4	653	201	0.98	0.9750	8.18	6.75

Glossary

ALK = Alkalinity, mg/L $CaCO_3$	TDS = Total dissolved solids, mg/L
TKN = Total Kjeldahl nitrogen, mg/L	TSS = Total suspended solids, mg/L
NH_3-N = Ammonia nitrogen, mg/L	TS = Total solids, mg/L
NO_2+NO_3-N = Nitrate + Nitrite nitrogen, mg/L	TVS = Total volatile solids, mg/L
NO_3-N = Nitrate + Nitrite nitrogen, mg/L	SECCHI = Secchi disk depth, ft.
TP = Total phosphorus, mg/L	COND = Conductivity, milliSiemens/cm
SRP = Soluble reactive phosphorus, mg/L	DO = Dissolved oxygen, mg/L
Cl^- = Chloride, mg/L	

k = Denotes that the actual value is known to be less than the value presented.

NA= Not applicable

* = Prior to 2006 only Nitrate - nitrogen was analyzed

Table 1 continued. Water quality data for Lake NaPaSuWe Outlet, 2002 and 2009.

2009	Outlet															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
12-May	0	141	0.87	<0.1	<0.05	0.034	<0.005	NA	105	9.6	403	99	1.87	0.7480	9.83	4.45
9-Jun	0	108	1.20	<0.1	<0.05	0.045	0.007	NA	106	6.5	364	83	2.13	0.5980	9.66	9.57
14-Jul	0	122	1.67	<0.1	<0.05	0.102	0.040	NA	109	92.4	460	138	NA	0.6080	9.61	7.31
11-Aug	0	125	1.47	<0.1	<0.05	0.082	<0.005	NA	109	20.0	393	110	NA	0.6340	9.37	8.17
15-Sep	0	126	1.26	<0.1	<0.05	0.020	<0.005	NA	105	3.5	372	96	NA	0.6070	9.2	4.97
	Average	124	1.29	<0.1	<0.05	0.057	0.024[k]	NA	107	26.4	398	105	NA	0.6390	9.53	6.89

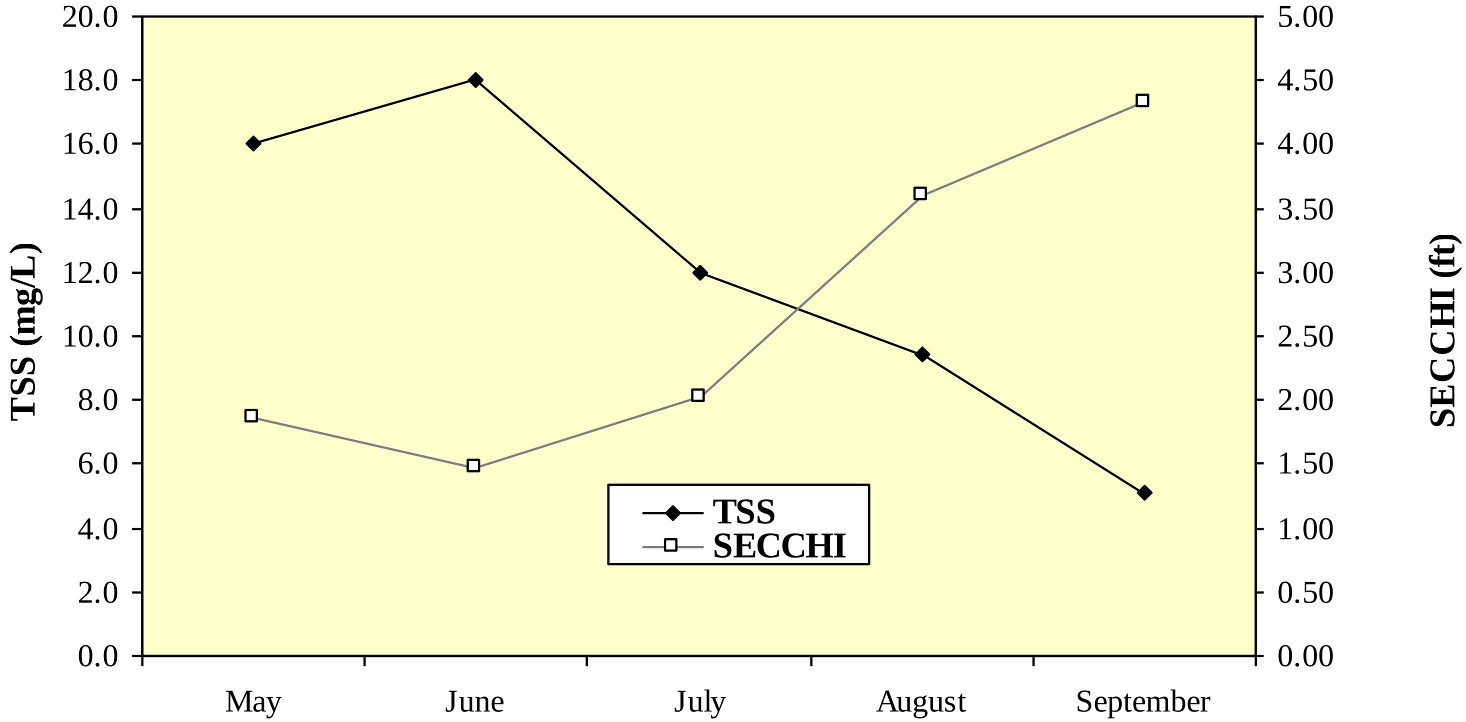
2002	Outlet															
DATE	DEPTH	ALK	TKN	NH3-N	NO3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
30-Apr	0	259	2.21	<0.1	<0.05	0.127	<0.005	594	NA	25.0	652	216	1.28	1.0180	8.17	9.08
5-Jun	0	238	2.72	0.153	0.056	0.181	<0.005	576	NA	52.0	595	157	0.92	0.8878	7.74	5.63
9-Jul	0	238	3.46	<0.1	<0.05	0.245	0.014	577	NA	59.0	661	193	0.56	0.9949	7.94	3.46
6-Aug	0	224	5.62	<0.1	<0.05	0.373	0.029	587	NA	122.0	763	250	0.72	1.0190	8.04	4.62
4-Sep	0	199	3.49	0.721	<0.05	0.226	0.020	536	NA	44.0	587	176	0.59	0.8846	7.61	3.06
	Average	232	3.50	0.437[k]	0.056[k]	0.230	0.021[k]	574	NA	60.4	652	198	0.81	0.9609	7.90	5.17

Glossary

ALK = Alkalinity, mg/L $CaCO_3$	TDS = Total dissolved solids, mg/L
TKN = Total Kjeldahl nitrogen, mg/L	TSS = Total suspended solids, mg/L
NH_3-N = Ammonia nitrogen, mg/L	TS = Total solids, mg/L
NO_2+NO_3-N = Nitrate + Nitrite nitrogen, mg/L	TVS = Total volatile solids, mg/L
NO_3-N = Nitrate + Nitrite nitrogen, mg/L	SECCHI = Secchi disk depth, ft.
TP = Total phosphorus, mg/L	COND = Conductivity, milliSiemens/cm
SRP = Soluble reactive phosphorus, mg/L	DO = Dissolved oxygen, mg/L
Cl^- = Chloride, mg/L	

k = Denotes that the actual value is known to be less than the value presented.
NA= Not applicable
* = Prior to 2006 only Nitrate - nitrogen was analyzed

Figure 4. Total suspended solid (TSS) concentrations vs. Secchi depth for Lake NaPaSuWe, 2009.



Environmental Protection Agency's (IEPA) Volunteer Lake Monitoring Program (VLMP) from 2006 to 2008. The VLMP Secchi depth averages over those three years were between 1.13 feet and 1.42 feet in 2007 and 2008 respectively (Figure 3). The VLMP data from 2006 through 2008 had an average Secchi depth of 1.24 feet while the LMU average from 2002 and 2009 was 1.62 feet. The volunteers at Lake NaPaSuWe have provided exceptional and accurate data that is vital for the continued monitoring and management of this lake. The Lakes Management Unit would like to thank them for the efforts.

Within the Mutton Creek Watershed, Ozaukee Lake had the lowest average Secchi depth (0.51 feet) and the highest average TSS concentration (80.1 mg/L, Table 2). The lake's shallow nature, abundant aquatic plants, and abundance of Common Carp contribute to the elevated concentrations of these parameters. Ozaukee Lake drains into Lake NaPaSuWe from the south. However, the higher TSS values within the lake are located at the north end at the outfall indicating that these parameters are being influenced internally. In contrast, Lake Fairfield had the greatest average Secchi depth (5.89 feet) and the lowest average TSS (5.1 mg/L). Lake Fairfield is located near the top of the watershed and is the deepest lake with in the watershed. In 2000 approximately 63% of the lake bottom in Lake Fairfield was covered with the macro algae Chara that competes with algae and stabilizes sediments within the lake.

Phosphorus is a nutrient that limits plant and algal growth, therefore any addition of phosphorus to the lake could produce algal blooms. Total phosphorus (TP) concentrations for the inlet and outlet averaged 0.069 mg/L and 0.057 mg/L respectively. The median for the county was 0.065 mg/L (Appendix C). The TP concentration for Lake NaPaSuWe in 2002 at the inlet was 0.203 mg/L and 0.230 mg/L at the outlet. Coupled with the high TP concentrations, Lake NaPaSuWe had trace concentrations of soluble reactive phosphorus (SRP) in July (0.006 mg/L) at the inlet and in June (0.007 mg/L) and July (0.040 mg/L) at the outlet. SRP is usually utilized by aquatic organisms as it becomes available. However, due to the concentrations of phosphorus, aquatic organisms were not able to assimilate all available SRP.

Phosphorus can enter a lake either internally (typically linked to sediment) or externally (point or non-point sources). Point source pollution can be from storm pipes or wastewater discharge and non-point source pollution from groundwater or surface runoff, which pick up phosphorus from agricultural fields, septic systems, impervious surfaces, or fertilized lawns. There were external sources of TP affecting Lake NaPaSuWe such as stormwater from the 665.66 acre watershed (Figure 4). Single family (32%), public and private open space (29.2%), and water (13%) were the major land uses within the watershed (Figure 5). For Lake NaPaSuwe single family (42%) transportation (35%), and Public and Private Open Space (19%) were the land uses contributing the highest percentages of estimated runoff (Table 3). It is important to keep in mind that although the amount of estimated runoff from certain areas may be low, they can still deliver high concentrations of TSS and TP. The retention time (the amount of time it takes for water entering a lake to flow out of it again) was calculated to be approximately 109 days. A watershed is an area of land that drains into a body of water, everyone lives in a watershed and the land management directly affects the water quality. In the Lake NaPaSuWe watershed where single family homes is the major land use contributing runoff, applying lawn fertilizers containing zero phosphorus would be an effective way to reduce phosphorus in the Lake NaPaSuWe watershed (Figure 6).

Figure 3. Secchi disk averages from VLMP, and LCHD for Lake NaPaSuWe.

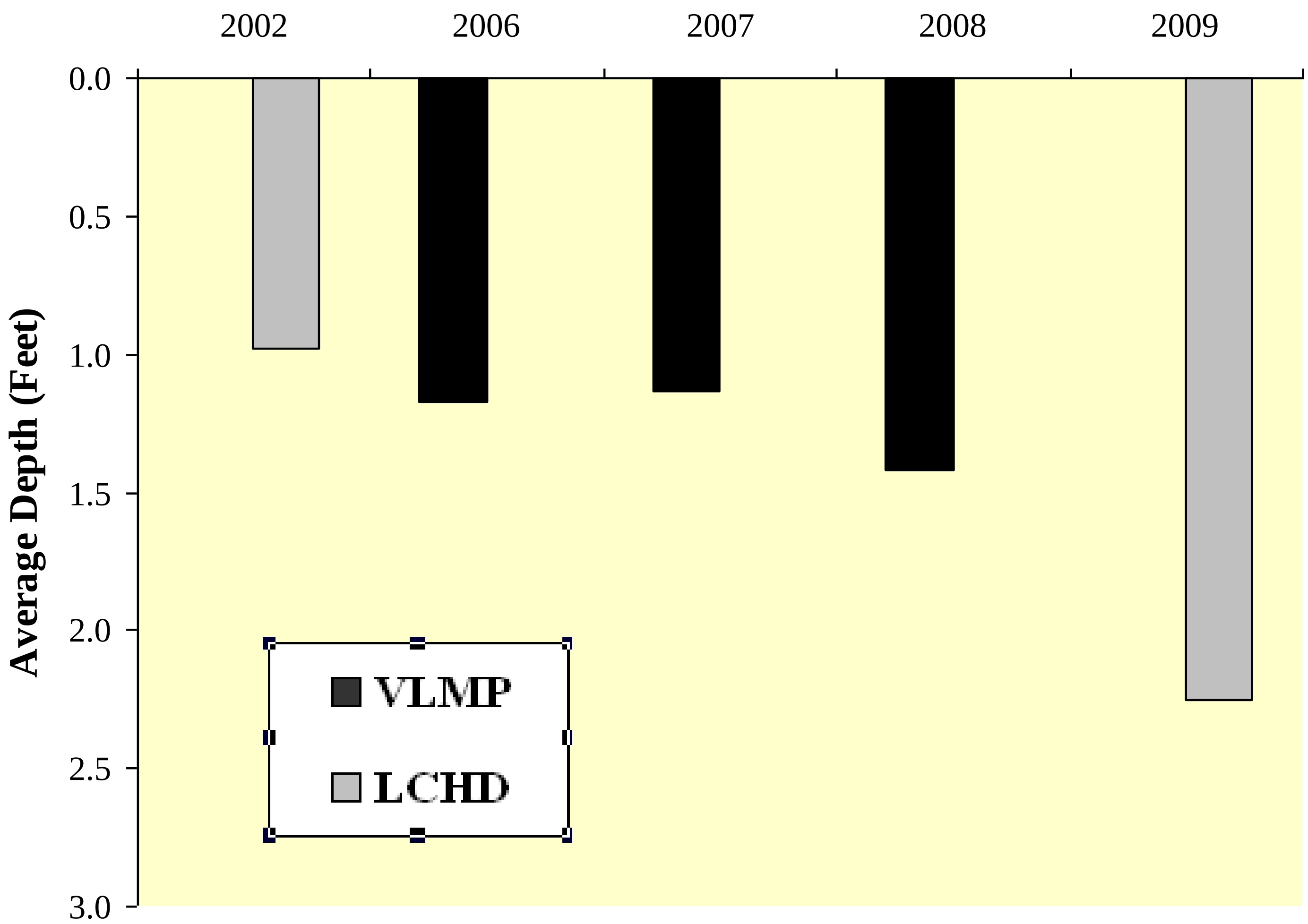


Table 2. Comparison of epilimnetic averages for Secchi disk transparency, total suspended solids, total phosphorus, and conductivity within the Mutton Creek watershed.

	Ozaukee Lake	Ozaukee Lake	Lake Napa SuWe Inlet	Lake Napa SuWe Outlet	Lake Napa SuWe Inlet	Lake Napa SuWe Outlet
Year	**2002**	**2009**	**2002**	**2002**	**2009**	**2009**
Secchi (feet)	0.81	0.51	0.98	0.81	2.66	NA
TSS (mg/L)	52.1	80.1	43.4	60.4	12.1	26.4
TP (mg/L)	0.15	0.22	0.2	0.23	0.07	0.06
Conductivity (milliSiemens/cm)	0.5801	0.4956	0.975	0.9609	0.6644	0.6390

	Fairfield Lake	Island Lake
Year	**2000**	**2003**
Secchi (feet)	5.89	2.9
TSS (mg/L)	5.1	14.9
TP (mg/L)	0.03	0.1
Conductivity (milliSiemens/cm)	0.6267	0.8376

Direction of Watershed Flow

Figure 4. Approximate watershed delineation for Lake NaPaSuwe, 2009.

Figure 5. Approximate land use within the Lake NaPaSuWe watershed, 2009.

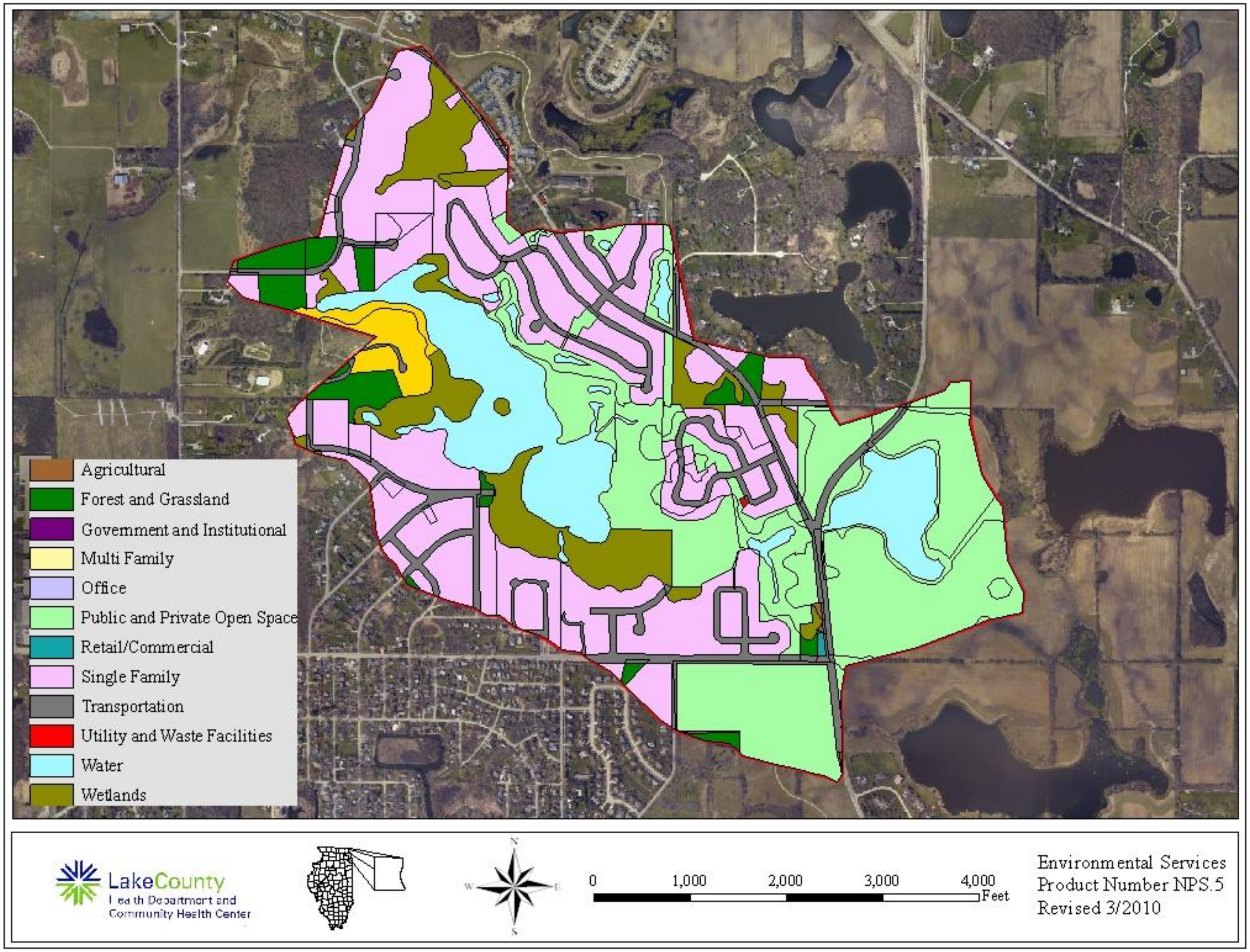


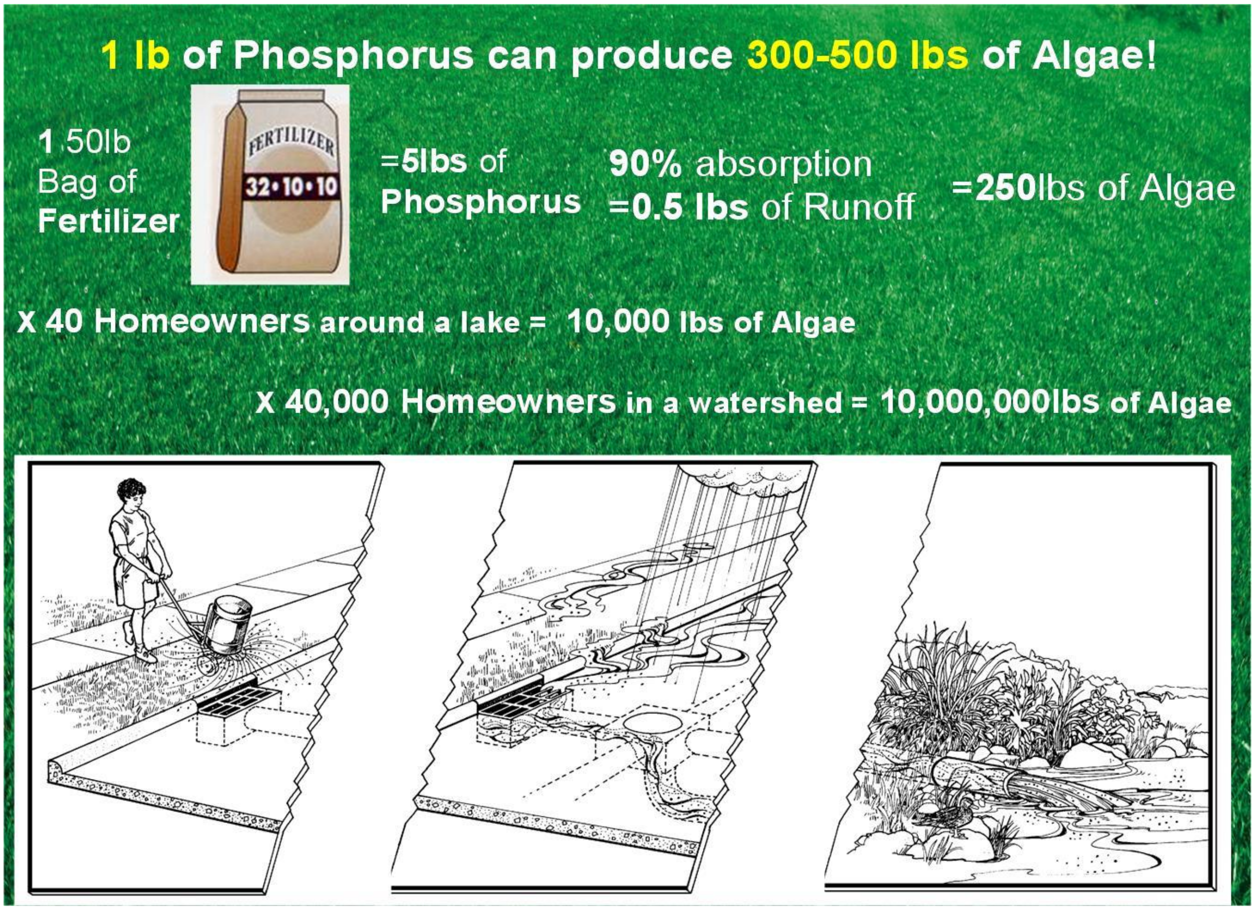
Figure 5. Approximate land use within the Ozaukee Lake watershed, 2009.

Land Use	Acreage	% of Total
Agricultural	0.75	0.1%
Disturbed Land	15.11	2.3%
Forest and Grassland	24.38	3.7%
Public and Private Open Space	194.70	29.2%
Retail/Commercial	0.47	0.1%
Single Family	215.48	32.4%
Transportation	64.02	9.6%
Utility and Waste Facilities	0.16	0.0%
Water	87.32	13.1%
Wetlands	63.28	9.5%
Total Acres	**665.66**	**100.0%**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% Total of Estimated Runoff
Agricultural	0.75	0.05	0.1	0.0%
Disturbed Land	15.11	0.05	2.1	0.5%
Forest and Grassland	24.38	0.05	3.4	0.8%
Public and Private Open Space	194.70	0.15	80.3	19.0%
Retail/Commercial	0.47	0.85	1.1	0.3%
Single Family	215.48	0.30	177.8	42.0%
Transportation	64.02	0.85	149.6	35.4%
Utility and Waste Facilities	0.16	0.30	0.1	0.0%
Water	87.32	0.00	0.0	0.0%
Wetlands	63.28	0.05	8.7	2.1%
TOTAL	**665.66**		**423.2**	**100.0%**

Lake volume	**126.20**	**acre-feet**
Retention Time (years)= lake volume/runoff	**0.30**	**years**
	108.85	**days**

Figure 6. Illustration of how phosphorus from lawn fertilizers enters a watershed.



Nitrogen is also critical for the growth of plants and algae. Nitrogen sources vary from fertilizer to human waste and sewage treatment plants, to groundwater, air, and rainfall. Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen, and is typically bound up in algal and plant cells. The 2009 average TKN concentrations for Lake NaPaSuWe at the inlet and outlet were 1.46 mg/L 1.29, respectively. These values are greater than the county median of 1.18 mg/L and a 49% and 63% decrease from the 2002 averages 2.85 mg/L and 3.50 mg/L, respectively. The low abundance of plants in Lake NaPaSuWe was a factor that influenced the high TKN values in 2002 since aquatic plants were not competing with the algae for the available nutrients. Typically, lakes are either phosphorus (P) or nitrogen (N) limited. This means that one of the nutrients is in short supply and any addition of that nutrient to the lake will result in an increase of plant and/or algal growth. Most lakes in Lake County are phosphorus limited. To compare the availability of nitrogen and phosphorus, a ratio of total nitrogen to total phosphorus (TN:TP) is used. Ratios less than or equal to 10:1 indicate nitrogen is limiting, ratios greater than or equal to 15:1 indicate phosphorus is limiting, and ratios greater than 10:1, but less than 15:1 indicate there is enough of both nutrients to facilitate excess algae or plant growth. In 2002 Lake NaPaSuWe on average was phosphorus limited (15:1) however in July 2002 there was a surplus of nitrogen and phosphorus (14:1) that supported large algae blooms in the lake. In 2009 the TN:TP ratio was 21:1 at the inlet and 23:1 at the outlet indicating that the lake was phosphorus limited throughout the season.

The Illinois EPA has indices used for assessing lakes for aquatic life and recreational use impairment. The indices are calculated using the mean trophic state index (TSI), percent macrophyte coverage, and the median nonvolatile suspended solids concentration. The TSI index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive), mesotrophic (intermediate nutrient availability and biological productivity), and eutrophic (nutrient-rich, highly productive), or hypereutrophic (extremely nutrient-rich and productive). This index can be calculated using TP values obtained at or near the surface. In 2002 Lake NaPaSuWe was hypereutrophic with a TSIp value of 82.6 with aquatic life having partial support and recreational use scoring a non support. In 2009 Lake NaPaSuWe was eutrophic with a TSIp value of 65.1 ranking the lake 68th out of 165 in the county (Table 4). The impairment indices determined that Lake NaPaSuWe had full support for aquatic life and partial support for recreational use do to the dense aquatic plant community. (The IEPA discontinued calculating the Swimming Use Index in 2007).

Alkalinity concentrations in Lake NaPaSuWe were high in 2002, with the seasonal averages of the inlet (227 mg/L) and outlet (232 mg/L) well above the county median for oxic samples (162 mg/L). The June concentrations at both sample locations had the highest concentrations 266 mg/L and 259 mg/L, respectively. This trend was also noted in 2009 for June concentrations at the inlet 187 mg/L and the outlet 141 mg/L. The seasonal averages in 2009 were below the county median of 161 mg/L. The inlet and outlet had reduced concentrations by 36% (145 mg/L) and 47% (126 mg/L) from the 2002 values. Alkalinity is a lake's buffer against acid rain and can be influenced by the type of minerals in the soils and watershed bedrock, and by how much the lake water comes into contact with these minerals. The average 2009 Alkalinity ($CaCO_3$) concentrations were below the county median of 161 mg/L. Alkalinity acts to buffer lakes from the effects of acid rain by neutralizing hydrogen ions from the acid inputs. The buffering occurs when excess hydrogen ions (H+) are removed from the water. As the hydrogen

Table 5. Lake County average TSI phosphorous (TSIp) ranking 2000-2009.

RANK	LAKE NAME	TP AVE	TSIp
1	Lake Carina	0.0100	37.35
2	Sterling Lake	0.0100	37.35
3	Independence Grove	0.0135	39.24
4	Lake Zurich	0.0130	41.14
5	Sand Pond (IDNR)	0.0165	41.36
6	West Loon Lake	0.0140	42.21
7	Windward Lake	0.0158	43.95
8	Cedar Lake	0.0170	45.00
9	Pulaski Pond	0.0180	45.83
10	Timber Lake	0.0180	45.83
11	Fourth Lake	0.0182	45.99
12	Lake Kathryn	0.0200	47.35
13	Highland Lake	0.0200	47.35
14	Banana Pond	0.0202	47.49
15	Lake Minear	0.0204	47.63
16	Cross Lake	0.0220	48.72
17	Sun Lake	0.0220	48.72
18	Dog Pond	0.0222	48.85
19	Lake of the Hollow	0.0230	49.36
20	Stone Quarry Lake	0.0230	49.36
21	Round Lake	0.0230	49.36
22	Deep Lake	0.0234	49.61
23	Bangs Lake	0.0240	49.98
24	Druce Lake	0.0244	50.22
25	Little Silver	0.0250	50.57
26	Lake Leo	0.0256	50.91
27	Dugdale Lake	0.0274	51.89
28	Peterson Pond	0.0274	51.89
29	Lake Miltmore	0.0276	51.99
30	Lake Fairfield	0.0296	53.00
31	Third Lake	0.0300	53.20
32	Gray's Lake	0.0302	53.29
33	Lake Catherine (Site 1)	0.0308	53.57
34	Lambs Farm Lake	0.0312	53.76
35	Old School Lake	0.0312	53.76
36	Sand Lake	0.0316	53.94
37	Lake Linden	0.0326	54.39
38	Gages Lake	0.0338	54.92
39	Honey Lake	0.0340	55.00
40	Hendrick Lake	0.0344	55.17
41	Cranberry Lake	0.0360	55.82
42	Sullivan Lake	0.0370	56.22
43	Diamond Lake	0.0372	56.30
44	Channel Lake (Site 1)	0.0380	56.60
45	Ames Pit	0.0390	56.98
46	Schreiber Lake	0.0400	57.34

Table 5. Continued.

RANK	LAKE NAME	TP AVE	TSIp
47	White Lake	0.0408	57.63
48	Hook Lake	0.0410	57.70
49	Potomac Lake	0.0424	58.18
50	Duck Lake	0.0426	58.25
51	Deer Lake	0.0434	58.52
52	Nielsen Pond	0.0448	58.98
53	Turner Lake	0.0458	59.30
54	Seven Acre Lake	0.0460	59.36
55	Willow Lake	0.0464	59.48
56	Lucky Lake	0.0476	59.85
57	East Meadow Lake	0.0478	59.91
58	Old Oak Lake	0.0490	60.27
59	East Loon Lake	0.0490	60.27
60	Countryside Lake	0.0490	60.27
61	College Trail Lake	0.0496	60.45
62	Lake Lakeland Estates	0.0524	61.24
63	Butler Lake	0.0528	61.35
64	West Meadow Lake	0.0530	61.40
65	Heron Pond	0.0545	61.80
66	Little Bear Lake	0.0550	61.94
67	Lucy Lake	0.0552	61.99
68	**Lake Napa Suwe (Outlet)**	**0.0570**	**62.45**
69	Lake Christa	0.0576	62.60
70	Lake Charles	0.0580	62.70
71	Owens Lake	0.0580	62.70
72	Crooked Lake	0.0608	63.38
73	Waterford Lake	0.0610	63.43
74	Wooster Lake	0.0610	63.43
75	Lake Naomi	0.0616	63.57
76	Lake Tranquility S1	0.0618	63.62
77	Werhane Lake	0.0630	63.89
78	Liberty Lake	0.0632	63.94
79	Countryside Glen Lake	0.0642	64.17
80	Lake Fairview	0.0648	64.30
81	Leisure Lake	0.0648	64.30
82	Davis Lake	0.0650	64.34
83	Tower Lake	0.0662	64.61
84	St. Mary's Lake	0.0666	64.70
85	Mary Lee Lake	0.0682	65.04
86	Hastings Lake	0.0684	65.08
87	Lake Helen	0.0720	65.82
88	Spring Lake	0.0726	65.94
89	ADID 203	0.0730	66.02
90	Bluff Lake	0.0734	66.10
91	Harvey Lake	0.0766	66.71
92	Broberg Marsh	0.0782	67.01

Table 5. Continued.

RANK	LAKE NAME	TP AVE	TSIp
93	Sylvan Lake	0.0794	67.23
94	Big Bear Lake	0.0806	67.45
95	Petite Lake	0.0834	67.94
96	Timber Lake (South)	0.0848	68.18
97	Lake Marie (Site 1)	0.0850	68.21
98	North Churchill Lake	0.0872	68.58
99	Grand Avenue Marsh	0.0874	68.61
100	Grandwood Park, Site II, Outflow	0.0876	68.65
101	North Tower Lake	0.0878	68.68
102	South Churchill Lake	0.0896	68.97
103	Rivershire Pond 2	0.0900	69.04
104	McGreal Lake	0.0914	69.26
105	Long Lake	0.0920	69.35
106	International Mine and Chemical Lake	0.0948	69.79
107	Eagle Lake (Site I)	0.0950	69.82
108	Valley Lake	0.0950	69.82
109	Dunns Lake	0.0952	69.85
110	Fish Lake	0.0956	69.91
111	Lochanora Lake	0.0960	69.97
112	Woodland Lake	0.0986	70.35
113	Island Lake	0.0990	70.41
114	McDonald Lake 1	0.0996	70.50
115	Nippersink Lake	0.1000	70.56
116	Longview Meadow Lake	0.1024	70.90
117	Lake Barrington	0.1053	71.30
118	Redwing Slough, Site II, Outflow	0.1072	71.56
119	Lake Forest Pond	0.1074	71.59
120	Bittersweet Golf Course #13	0.1096	71.88
121	Fox Lake (Site 1)	0.1098	71.90
122	Osprey Lake	0.1108	72.04
123	Bresen Lake	0.1126	72.27
124	Round Lake Marsh North	0.1126	72.27
125	Deer Lake Meadow Lake	0.1158	72.67
126	Taylor Lake	0.1184	72.99
127	Columbus Park Lake	0.1226	73.49
128	Nippersink Lake (Site 1)	0.1240	73.66
129	Echo Lake	0.1250	73.77
130	Grass Lake (Site 1)	0.1288	74.21
131	Lake Holloway	0.1322	74.58
132	Lakewood Marsh	0.1330	74.67
133	Redhead Lake	0.1412	75.53
134	Forest Lake	0.1422	75.63
135	Antioch Lake	0.1448	75.89
136	Slocum Lake	0.1496	76.36
137	Pond-a-Rudy	0.1514	76.54
138	Lake Matthews	0.1516	76.56

Table 5. Continued.

RANK	LAKE NAME	TP AVE	TSIp
139	Buffalo Creek Reservoir	0.1550	76.88
140	Pistakee Lake (Site 1)	0.1592	77.26
141	Grassy Lake	0.1610	77.42
142	Salem Lake	0.1650	77.78
143	Half Day Pit	0.1690	78.12
144	Lake Eleanor Site II, Outflow	0.1812	79.13
145	Lake Farmington	0.1848	79.41
146	Lake Louise	0.1850	79.43
147	ADID 127	0.1886	79.71
148	Patski Pond (outlet)	0.1970	80.33
149	Summerhill Estates Lake	0.1990	80.48
150	Dog Bone Lake	0.1990	80.48
151	Redwing Marsh	0.2072	81.06
152	Stockholm Lake	0.2082	81.13
153	Bishop Lake	0.2156	81.63
154	Ozaukee Lake	0.2200	81.93
155	Hidden Lake	0.2236	82.16
156	Fischer Lake	0.2278	82.43
157	Oak Hills Lake	0.2792	85.36
158	Loch Lomond	0.2954	86.18
159	McDonald Lake 2	0.3254	87.57
160	Fairfield Marsh	0.3264	87.61
161	ADID 182	0.3280	87.69
162	Slough Lake	0.4134	91.02
163	Flint Lake Outlet	0.4996	93.75
164	Rasmussen Lake	0.5025	93.84
165	Albert Lake, Site II, outflow	1.1894	106.26

ions are removed, pH goes up. This was documented by the high pH values for the inlet and outlet 9.12 and 9.53 respectively. This was influenced by the large populations of aquatic plants. As aquatic plants under go the photosynthesis pH is raised because the process consumes protons (H+). The median pH value for the county was 8.35. Aquatic organisms need the pH of their water body to be within a certain range for optimal growth and survival. Although each organism has an ideal pH, most aquatic organisms prefer pH of 6.5 – 8.0. Outside of this range, organisms become physiologically stressed. Reproduction can be impacted by out-of-range pH, and organisms may even die if the pH gets too far from their optimal range.

Conductivity readings, which are correlated with chloride concentrations, have been increasing throughout the county in the past few years (Figure 7). Road salts used in winter road maintenance consist of sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanides which are detected when chlorides are analyzed. The 2009 average conductivity reading for Lake NaPaSuWe at the inlet was 0.6644 mS/cm and 0.6390 mS/cm at the outlet. These concentrations were lower than the county median of 0.7910 mS/cm and a 32% and 34% decrease since 2002 (0.9750 mS/cm and 0.9609 mS/cm, respectively). The chloride concentration averaged 105 mg/L at the inlet and 107 mg/L at the outlet for the season and was considerably less than the county median of 145 mg/L. A study done in Canada reported 10% of aquatic species were harmed by prolonged exposure to chloride concentrations greater than 220 mg/L. Additionally, shifts in algal populations were associated with chloride concentrations as low as 12 mg/l. (potentially shifts from green algae to blue-green algae). It appears that road salt is compounding in many lakes in the county. Some lakes in the county have seen a doubling of conductivity readings in the past 5-10 years. Chlorides are not utilized in a lake ecosystem and often persist in a lake until they are diluted from seasonal rain events. Alternatives to road salt should be considered. While alternatives may contain chloride, they tend to work faster at lower temperatures and therefore require less application to achieve the same result that common road salt.

SUMMARY OF AQUATIC MACROPHYTES

Plant sampling was conducted on Lake NaPaSuWe in July 2009. There were 92 points generated based on a computer grid system with points 60 meters apart (Figure 8). Sampling occurred at 89 points and aquatic plants existed at 88 of the 89 sites (Figure 9) that included 7 aquatic plant species two of which were exotic and invasive species: Curlyleaf Pondweed and Eurasian Watermilfoil (Table 5). Both of these exotics compete with native plants, eventually crowding them out, providing little or poor natural diversity in addition to limited uses by wildlife. Removal or control of exotic species is recommended. The diversity of plants since 2002 has decreased; Bladderwort and Flatstem Pondweed were not documented in the 2009 assessments. However the density of aquatic plants has dramatically increased since 2002 when the populations were considered *almost nonexistent*. In 2009 aquatic plants encompassed 99% of the lake; the aquatic plant community dominant species were Coontail (93%) and Eurasian Watermilfoil (89%) followed by Watermeal (82%) a floating aquatic plant. Another aquatic plant that was abundant was Common Duckweed that was found at 47% of the sites. Species in

Figure 7. Chloride (Cl^-) concentration vs. conductivity for Lake NaPaSuWe, 2009.

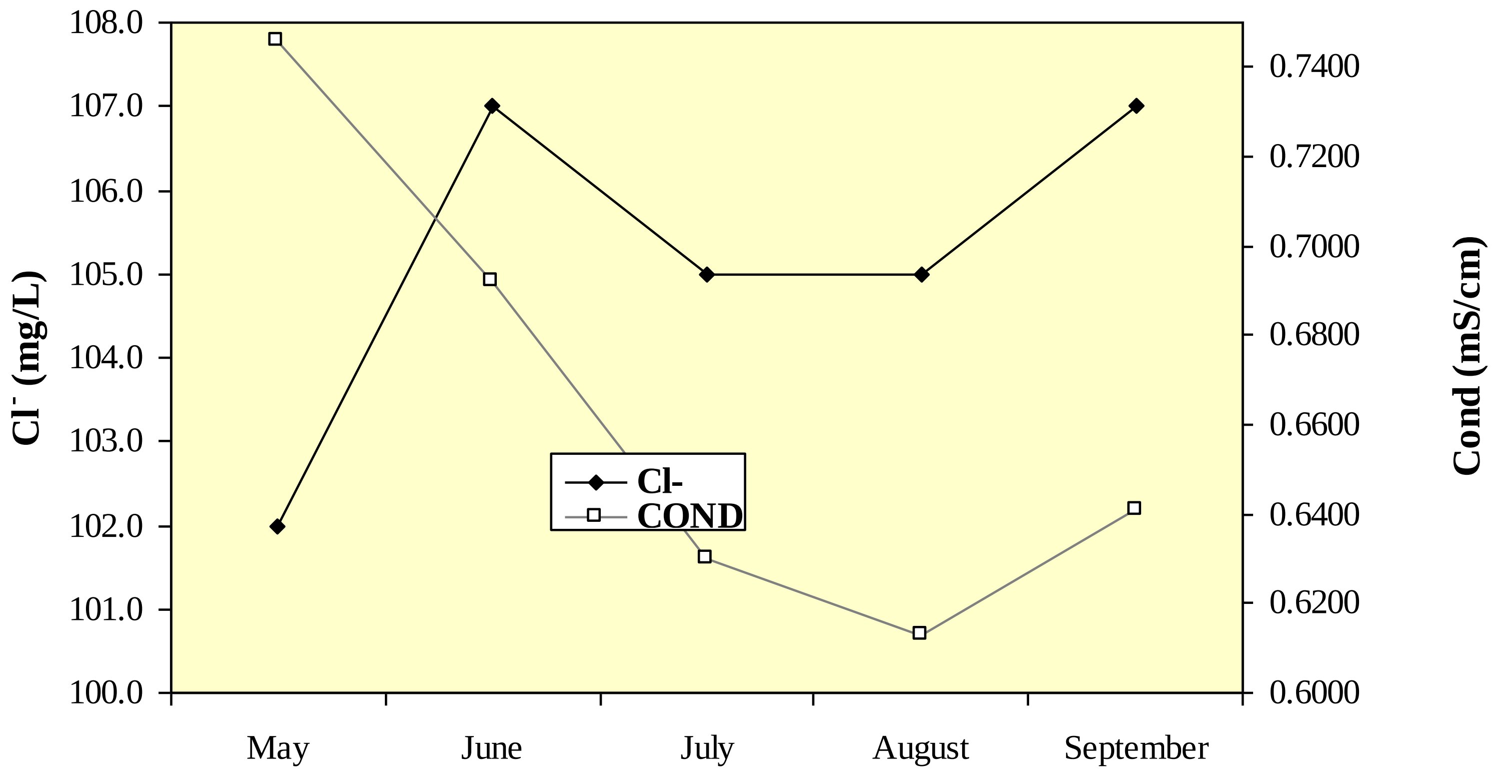


Figure 8. Aquatic plant sampling grid on Lake NaPaSuWe, July 2009.

Figure 9. Aquatic plant sampling grid that illustrates plant density on Lake NaPaSuWe, July 2009.

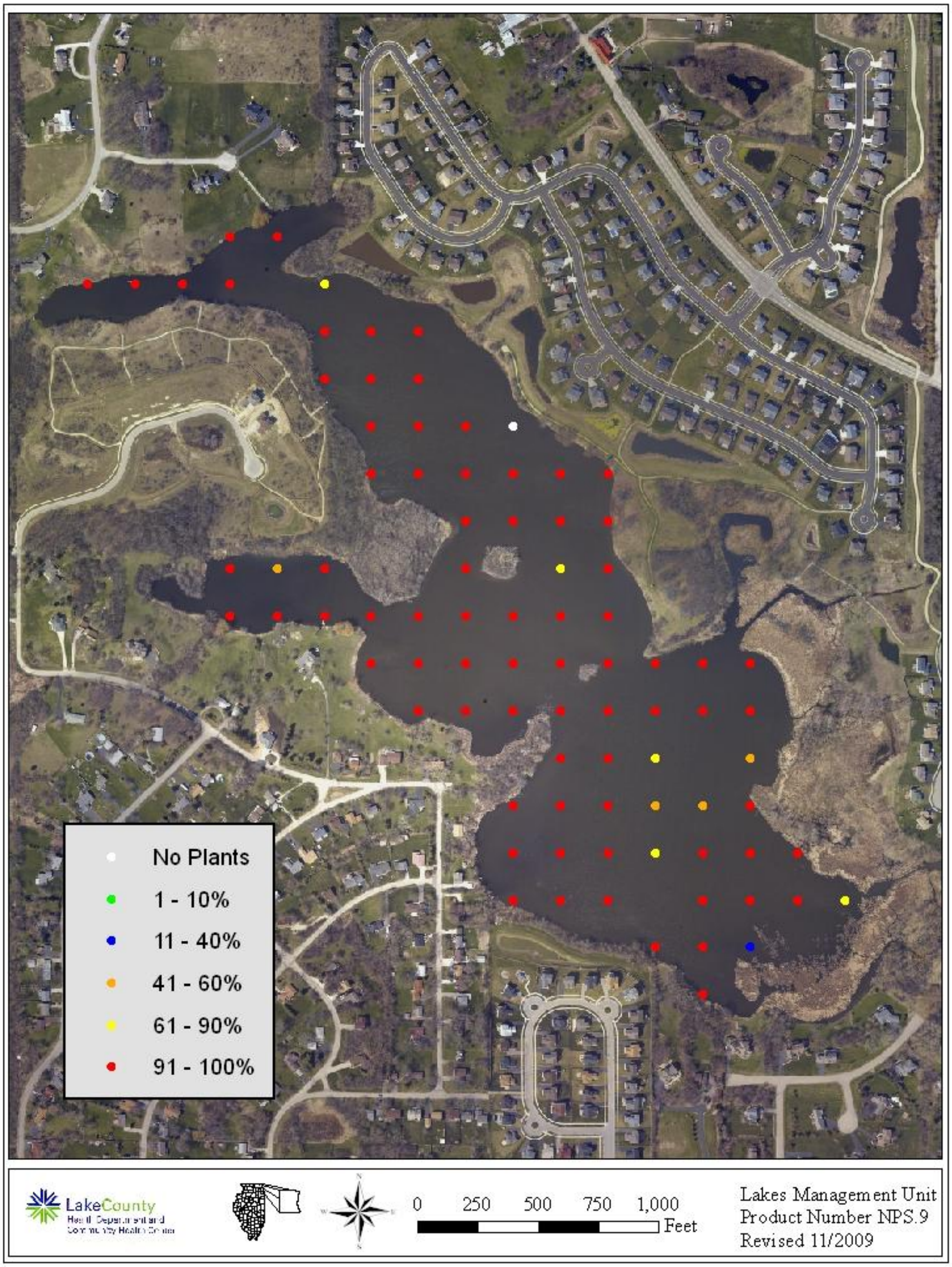


Table 5. Aquatic plant species found in Lake NaPaSuWe in 2009.

Coontail	*Ceratophyllum demersum*
Duckweed	*Lemna* spp.
Star Duckweed	*Lemna trisulca*
Eurasian Watermilfoil^	*Myriophyllum spicatum*
Curlyleaf Pondweed^	*Potamogeton crispus*^
Sago Pondweed	*Potamogeton pectinatus*
Watermeal	*Wolffia columbiana*

^ Exotic plant

Table 6. Aquatic vegetation species found at the 89 July sampling sites on Lake NaPaSuWe, 2009.

Plant Density	Coontail	Curlyleaf Pondweed	Duckweed	Eurasian Watermilfoil	Sago Pondweed	Star Duckweed	Watermeal
Present	0	4	40	2	2	5	57
Common	4	3	1	10	3	0	14
Abundant	17	0	0	19	0	0	2
Dominant	62	2	1	48	0	0	0
% Plant Occurrence	93.3	10.1	47.2	88.8	5.6	5.6	82.0

Table 6b. Distribution of rake density across all sampling sites.

Rake Density (coverage)	# of Sites	% of Sites
No Plants	1	1.1
>0-10%	0	0.0
10-40%	1	1.1
40-60%	4	4.5
60-90%	5	5.6
>90%	78	87.6
Total Sites with Plants	88	98.9
Total # of Sites	89	100.0

low abundance included: Curlyleaf Pondweed (10%), Sago Pondweed (6%) and Star Duckweed (6%). Aquatic vegetation provides important wildlife habitat and food sources. Additionally, aquatic plants provide many water quality benefits such as sediment stabilization and competition with algae for available resources. The aquatic plant community in 2009 improved a variety of water quality parameters in Lake NaPaSuWe including: increased water clarity, decreased turbidity, decreased nuisance algae blooms, and potentially increased fishery health. A truly healthy aquatic plant community contains a large number of plant species that provide different types of habitat and structure to the lake that covers 30-40% of the lake. In 2009 Lake NaPaSuWe had an aquatic plant community that coved 99% of the lake bottom, and was had limited plant diversity that with abundant populations of Eurasian Watermilfoil (EWM) (Figure 10). High densities of EWM were found throughout the lake except near the inlet sampling location, where Coontail was dominate. Coontail was also distributed throughout the lake at nuisance densities.

The diversity and health of plant populations can be influenced by a variety of factors. Water clarity and depth are the major limiting factors in determining the maximum depth at which aquatic plants will grow. When the light level in the water column falls below 1% of the surface light level, plants can no longer photosynthesize. The 1% light level in Lake NaPaSuWe reached to the bottom of the lake throughout the sampling season May - September. The light level readings at the inlet sampling location were influenced by the Coontail densities (Figure 11). Most of the lake had aquatic plant densities greater than 90% with the exception of the inlet sampling location on the south side of the lake which is the deepest part of the lake (Figure 12).

Floristic quality index (FQI) is an assessment tool designed to evaluate the closeness the flora of an area is to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts. Each aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). This is done for every floating and submersed plant species found in the lake. An FQI is calculated by multiplying the average of these numbers by the square root of the number of these plant species found in the lake. A high FQI number indicates that a large number of sensitive, high quality plant species present in the lake. Non-native species were also included in the FQI calculations for Lake County lakes. The average FQI for Lake County lakes from 2000-2009 was 13.7. Lake NaPaSuWe had an FQI of 11.7 in 2009 which is only a slight decrease since 2002 (11.8), and was below average by Lake County standards ranking 89th of 152 lakes (Table 8).

SUMMARY OF SHORELINE CONDITION

The lake has undergone several changes over the years. Aerial photography shows no development on the northwest or northeast corner of the lake in 1993. By 2000 the lots on the North West side of the lake were large residential lots. By 2004 the entire North East shore was developed into single family homes. Additionally, the 1993 photo shows an island on the south west side of the lake near the bay by West Garner Road. This island is not located near the bay in the 2007 aerial photo possibly due to the outlet rehabilitation, which increased lake levels. Causing the cattail “island” to float to so one could assume that it floated to its new south central

Figure 10. Aquatic plant sampling grid that illustrates plant density of Eurasian Watermilfoil on Lake NaPaSuWe, July 2009.

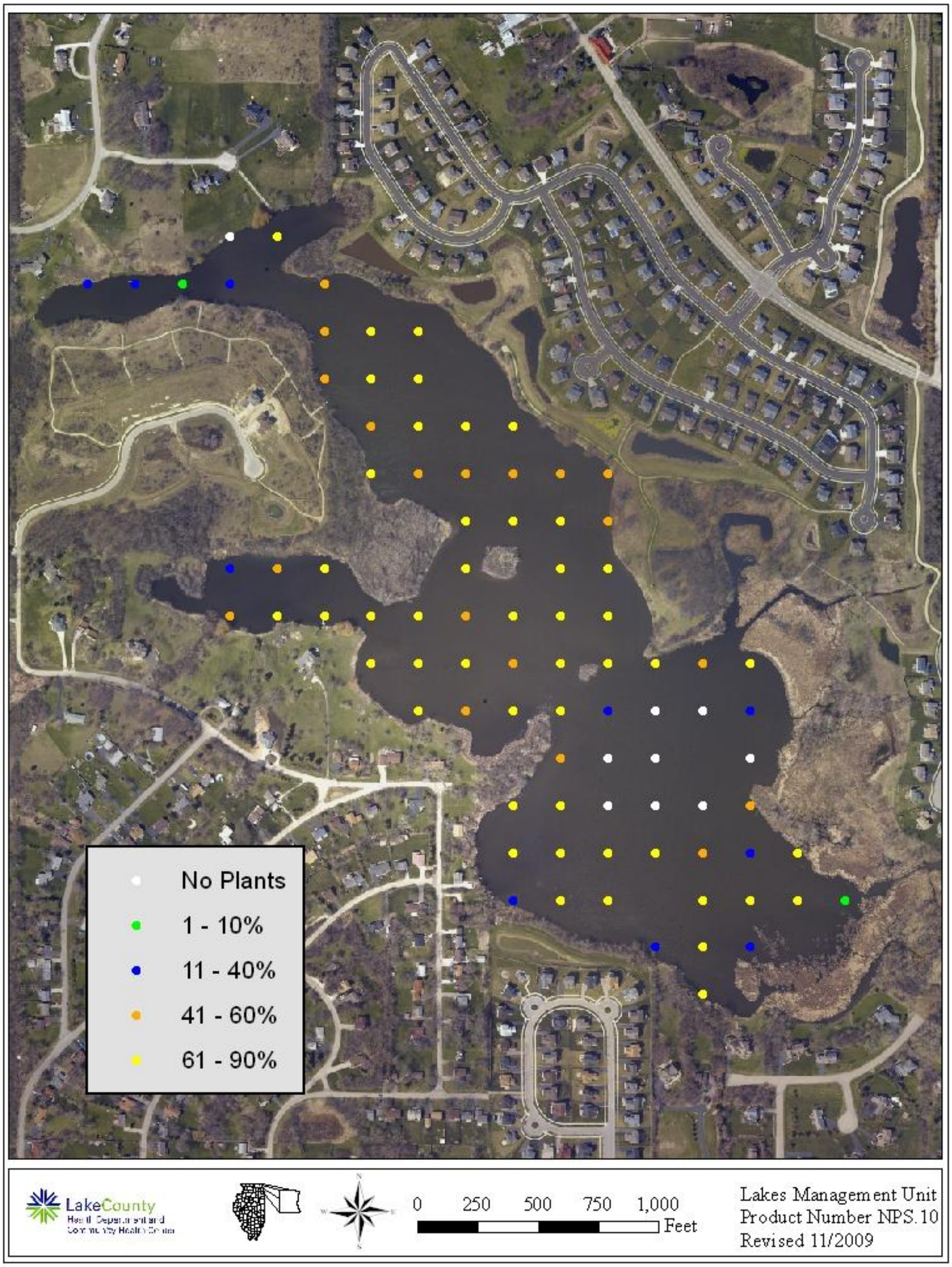


Figure 11. Aquatic plant sampling grid that illustrates plant density of Coontail on Lake NaPaSuWe, July 2009.

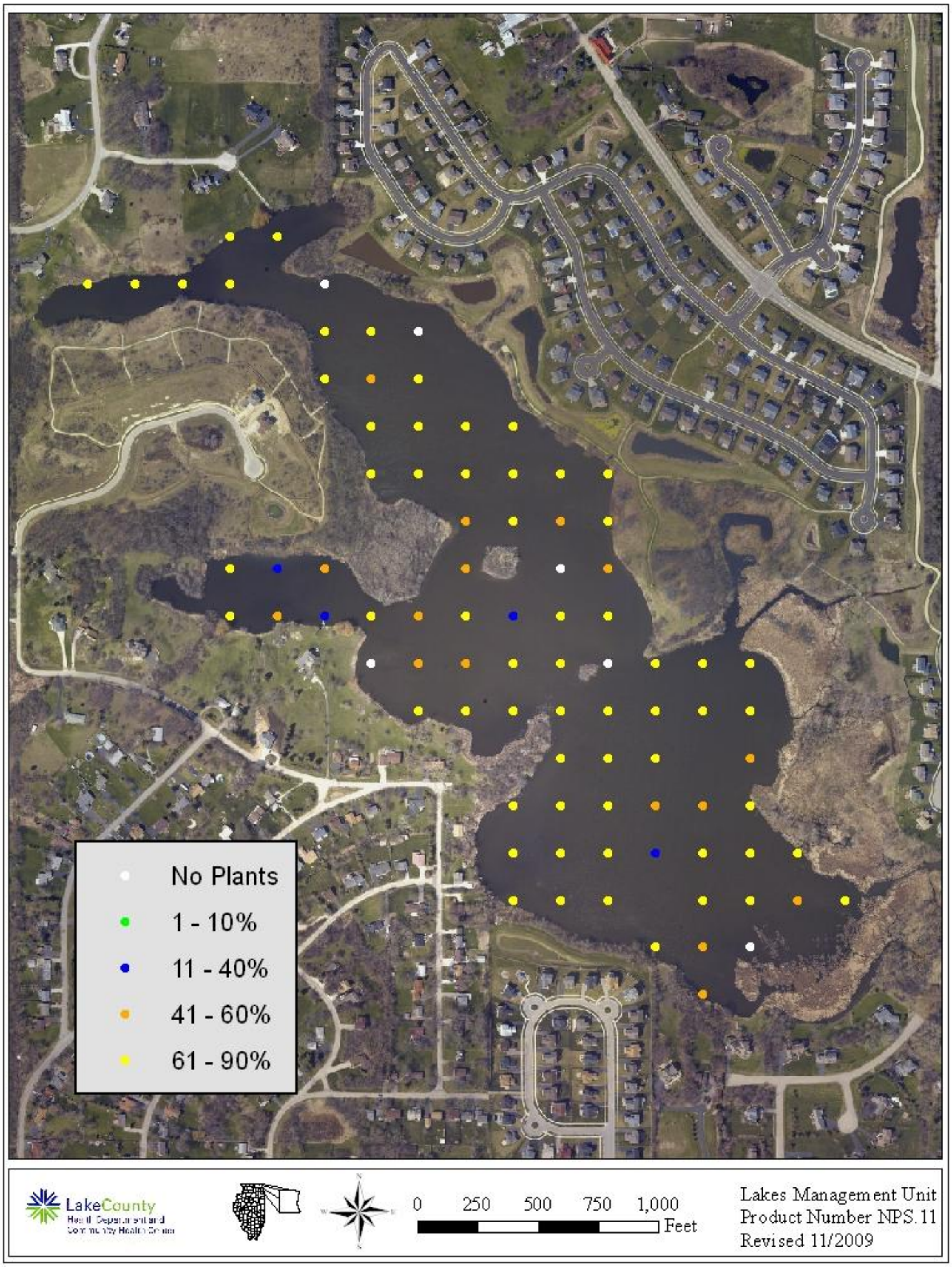


Figure 12. Bathymetric map of Lake NaPaSuWe, 2009.

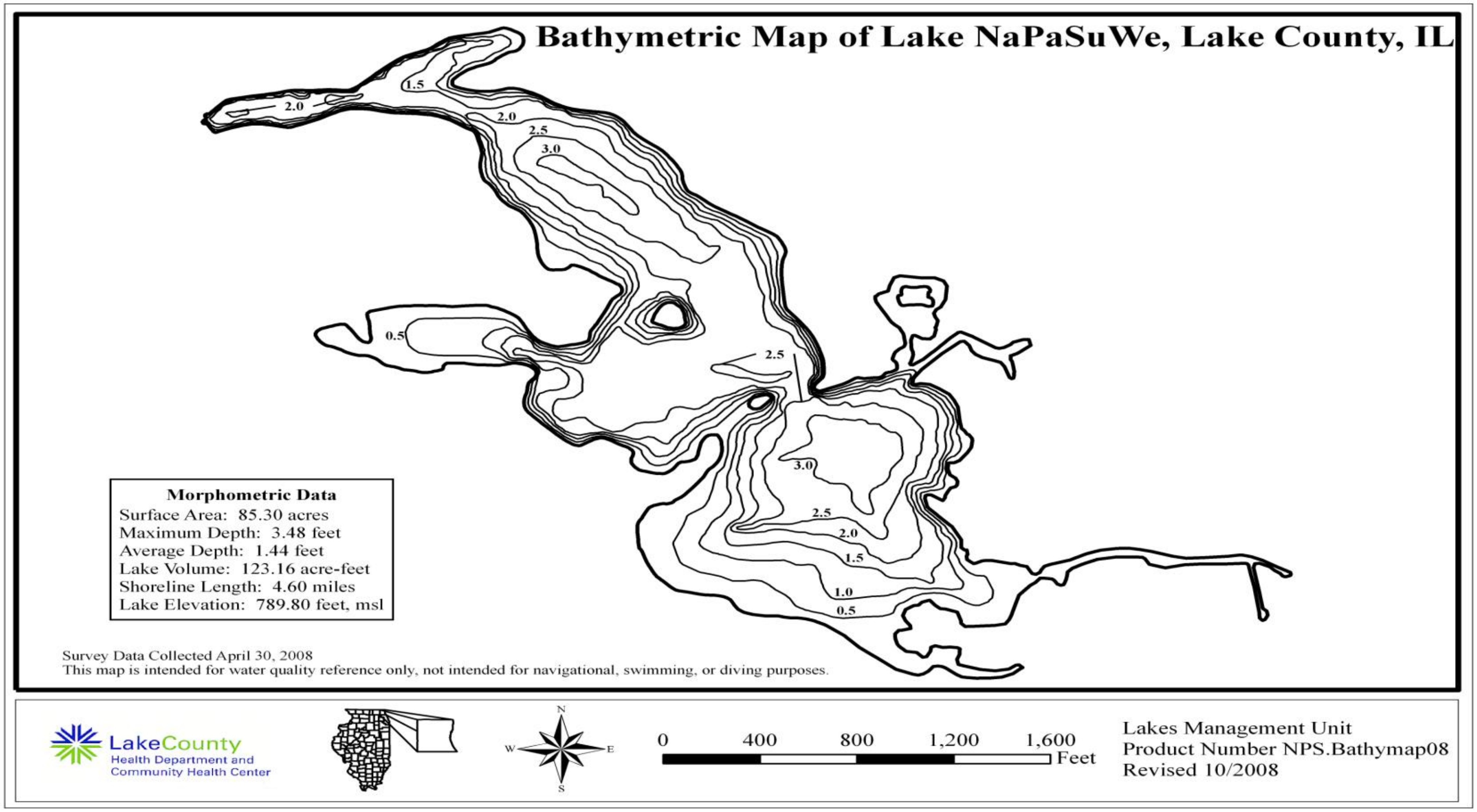


Table 7. Morphometric features of Lake NaPaSuWe, 2009.

Morphometric Features of Lake NaPaSuWe ~
Data From the April 2008 Bathymetric Survey, LCHD Lakes Management Unit

Contour (Feet)	Area Enclosed (Acres)	Percent of total acres	Volume (Acre-feet)	Depth Zone (Feet)	Area (Acres)	Percent (Depth zone to total acres)	Percent (Acre-feet to Total Volume)
0	85.30	100.0%	69.37	0 - 1	30.72	36.0%	56.3%
1	54.58	64.0%	41.99	1 - 2	24.02	28.2%	34.1%
2	30.56	35.8%	10.19	2 - 3	27.49	32.2%	8.3%
3	3.07	3.6%	1.61	3+	3.07	3.6%	1.3%
			123.16		85.30	100%	100%

Maximum Depth of Lake: 3.48 Feet
Average Depth of Lake: 1.44 Feet
Volume of Lake: 123.16 Acre-Feet

Area of Lake: 85.30 Acres
Shoreline Length: 4.60 Miles
Water elevation at 789.80 feet above mean sea level

LakeCounty Health Department and Community Health Center

1.4437728 = average depth

Table 8. Floristic quality index (FQI) of lakes in Lake County, calculated with exotic species (w/Adventives) and with native species only (native)

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	38.2	40.2
2	Cranberry Lake	32.5	33.3
3	East Loon Lake	30.6	32.7
4	Deep Lake	29.7	31.2
5	Little Silver	29.6	31.6
6	Bangs Lake	29.5	31.0
7	Round Lake Marsh North	29.1	29.9
8	Deer Lake	28.2	29.7
9	Sullivan Lake	26.9	28.5
10	West Loon Lake	25.7	27.3
11	Cross Lake	25.2	27.8
12	Wooster Lake	25.0	26.6
13	Independence Grove	24.6	27.5
14	Sterling Lake	24.5	26.9
15	Lake Zurich	24.3	27.1
16	Sun Lake	24.3	26.1
17	Schreiber Lake	23.9	24.8
18	Lakewood Marsh	23.8	24.7
19	Round Lake	23.5	25.9
20	Honey Lake	23.3	25.1
21	Fourth Lake	23.0	24.8
22	Lake of the Hollow	23.0	24.8
23	Druce Lake	22.8	25.2
24	Countryside Glen Lake	21.9	22.8
25	Butler Lake	21.4	23.1
26	Davis Lake	21.4	21.4
27	Duck Lake	21.1	22.9
28	Timber Lake (North)	20.8	22.8
29	ADID 203	20.5	20.5
30	Broberg Marsh	20.5	21.4
31	McGreal Lake	20.2	22.1
32	Lake Kathryn	19.6	20.7
33	Fish Lake	19.3	21.2
34	Redhead Lake	19.3	21.2
35	Turner Lake	18.6	21.2
36	Salem Lake	18.5	20.2
37	Lake Miltmore	18.4	20.3
38	Lake Helen	18.0	18.0
39	Old Oak Lake	18.0	19.1
40	Hendrick Lake	17.7	17.7
41	Long Lake	17.2	19.0
42	Seven Acre Lake	17.0	15.5
43	Gray's Lake	16.9	19.8
44	Owens Lake	16.3	17.3

Table 8. Continued

Rank	LAKE NAME	FQI (w/A)	FQI (native)
45	Countryside Lake	16.7	17.7
46	Highland Lake	16.7	18.9
47	Lake Barrington	16.7	17.7
48	Bresen Lake	16.6	17.8
49	Diamond Lake	16.3	17.4
50	Windward Lake	16.3	17.6
51	Dog Bone Lake	15.7	15.7
52	Redwing Slough	15.6	16.6
53	Osprey Lake	15.5	17.3
54	Lake Fairview	15.2	16.3
55	Heron Pond	15.1	15.1
56	Lake Tranquility (S1)	15.0	17.0
57	North Churchill Lake	15.0	15.0
58	Dog Training Pond	14.7	15.9
59	Island Lake	14.7	16.6
60	Grand Avenue Marsh	14.3	16.3
61	Lake Nippersink	14.3	16.3
62	Taylor Lake	14.3	16.3
63	Dugdale Lake	14.0	15.1
64	Eagle Lake (S1)	14.0	15.1
65	Longview Meadow Lake	13.9	13.9
66	Third Lake	13.9	16.6
67	Ames Pit	13.4	15.5
68	Bishop Lake	13.4	15.0
69	Buffalo Creek Reservoir	13.1	14.3
70	Mary Lee Lake	13.1	15.1
71	McDonald Lake 2	13.1	14.3
72	Old School Lake	13.1	15.1
73	Dunn's Lake	12.7	13.9
74	Summerhill Estates Lake	12.7	13.9
75	Timber Lake (South)	12.7	14.7
76	White Lake	12.7	14.7
77	Hastings Lake	12.5	14.8
78	Sand Lake	12.5	14.8
79	Stone Quarry Lake	12.5	12.5
80	Lake Carina	12.1	14.3
81	Lake Leo	12.1	14.3
82	Lambs Farm Lake	12.1	14.3
83	Pond-A-Rudy	12.1	12.1
84	Stockholm Lake	12.1	13.5
85	Grassy Lake	12.0	12.0
86	Lake Matthews	12.0	12.0
87	Flint Lake	11.8	13.0
88	Harvey Lake	11.8	13.0
89	**Lake Napa Suwe**	**11.7**	**13.9**
90	Rivershire Pond 2	11.5	13.3

Table 8. Continued

Rank	LAKE NAME	FQI (w/A)	FQI (native)
91	Antioch Lake	11.3	13.4
92	Hook Lake	11.3	13.4
93	Lake Charles	11.3	13.4
94	Lake Linden	11.3	11.3
95	Lake Naomi	11.2	12.5
96	Pulaski Pond	11.2	12.5
97	Lake Minear	11.0	13.9
98	Redwing Marsh	11.0	11.0
99	Tower Lake	11.0	11.0
100	West Meadow Lake	11.0	11.0
101	Nielsen Pond	10.7	12.0
102	Lake Holloway	10.6	10.6
103	Crooked Lake	10.2	12.5
104	College Trail Lake	10.0	10.0
105	Lake Lakeland Estates	10.0	11.5
106	Valley Lake	9.9	9.9
107	Werhane Lake	9.8	12.0
108	Big Bear Lake	9.5	11.0
109	Little Bear Lake	9.5	11.0
110	Loch Lomond	9.4	12.1
111	Columbus Park Lake	9.2	9.2
112	Sylvan Lake	9.2	9.2
113	Fischer Lake	9.0	11.0
114	Grandwood Park Lake	9.0	11.0
115	Lake Fairfield	9.0	10.4
116	Lake Louise	9	10.4
117	McDonald Lake 1	8.9	10.0
118	East Meadow Lake	8.5	8.5
119	Lake Christa	8.5	9.8
120	Lake Farmington	8.5	9.8
121	Lucy Lake	8.5	9.8
122	South Churchill Lake	8.5	8.5
123	Bittersweet Golf Course #13	8.1	8.1
124	Woodland Lake	8.1	9.9
125	Albert Lake	7.5	8.7
126	Banana Pond	7.5	9.2
127	Fairfield Marsh	7.5	8.7
128	Lake Eleanor	7.5	8.7
129	Patski Pond	7.1	7.1
130	Rasmussen Lake	7.1	7.1
131	Slough Lake	7.1	7.1
132	Lucky Lake	7.0	7.0
133	Lake Forest Pond	6.9	8.5
134	Ozaukee Lake	6.7	8.7
135	Leisure Lake	6.4	9.0
136	Peterson Pond	6.0	8.5

Table 8. Continued

Rank	LAKE NAME	FQI (w/A)	FQI (native)
137	Gages Lake	5.8	10.0
138	Slocum Lake	5.8	7.1
139	Deer Lake Meadow Lake	5.2	6.4
140	ADID 127	5.0	5.0
141	IMC Lake	5.0	7.1
142	Liberty Lake	5.0	5.0
143	Oak Hills Lake	5.0	5.0
144	Forest Lake	3.5	5.0
145	Sand Pond (IDNR)	3.5	5.0
146	Half Day Pit	2.9	5.0
147	Lochanora Lake	2.5	5.0
148	Echo Lake	0.0	0.0
149	Hidden Lake	0.0	0.0
150	North Tower Lake	0.0	0.0
151	Potomac Lake	0.0	0.0
152	St. Mary's Lake	0.0	0.0
153	Waterford Lake	0.0	0.0
154	Willow Lake	0.0	0.0
	Mean	**13.7**	**15.0**
	Median	**12.5**	**14.3**

location in the main body of the lake. The fact that the island floated opposed to being flooded is supported by the bathymetric map created in 2008 that shows no increase in elevation in that area (Figure 12). It is probable that changes in shoreline will continue to occur with the development of the northwest shorelines.

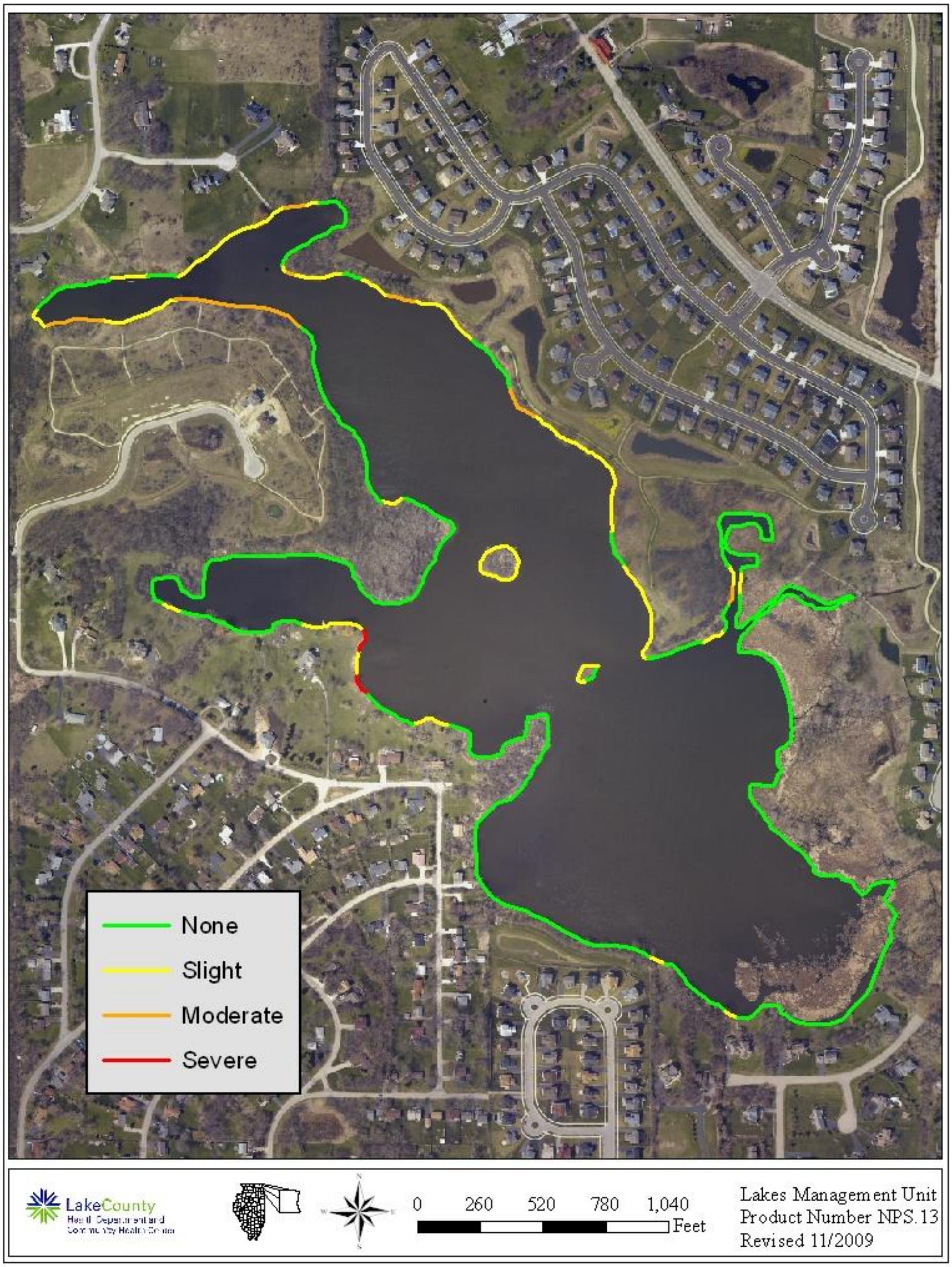
A shoreline assessment was conducted in July 2002 to determine the condition of the lake shoreline. Of particular interest was the condition of the shoreline at the water/land interface. A large majority (81%) of Lake NaPaSuWe's shoreline is undeveloped. A majority of the undeveloped shoreline consisted of wetland (40%) and shrub (38%). Developed shorelines were dominated by buffer areas (75%) and lawn (24%). The high occurrence of buffered areas on the developed shores combined with the dominance of wetland and shrub areas on the undeveloped shorelines is encouraging, as they contain plants with deep root systems that are less prone to erosion and provide good wildlife habitat. Also noted during the assessment was that there are no seawalls on the lake, which is unusual for a residential lake within Lake County. Seawalls (and rip rap to an extent) are undesirable because of their tendency to reflect wave action back into the lake. This can cause resuspension of near shore sediments, which can lead to a variety of water quality problems. These types (seawall and rip rap) of shoreline are often considered undesirable. However, manicured lawn, which accounted for 25% of the developed shoreline, is also a poor shoreline/water interface. This is due to the poor root structure of turf grasses, which are unable to adequately stabilize soil, which may lead to erosion. Additionally, manicured lawn provides little wildlife habitat.

The shoreline was reassessed in 2009 for changes in erosion since 2002. Based on the 2009 assessment, there was a significant increase in shoreline erosion from 14% to 23% of the shoreline having some degree of erosion (Figure 13). Overall, 18% of the shoreline had slight erosion, 4% had moderate erosion, and 1% had severe erosion. The severe and moderately eroded areas should be remediated immediately to prevent additional loss of shoreline and prevent continued degradation of the water quality through sediment inputs. It is much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion. If these shorelines are repaired by the installation of a buffer strip with native plants, the benefits can be three-fold. First, the erosion is repaired and the new native plants can stabilize the shoreline to prevent future erosion. Second, the addition of native plants adds habitat for wildlife to a shoreline that is otherwise limited in habitat. Thirdly, buffer habitat can help filter pollutants and nutrients from the near shore areas and keep geese and gulls from congregating, as it is not desirable habitat for them.

OBSERVATIONS OF WILDLIFE AND HABITAT

Wildlife observations were made on a monthly basis during water quality and plant sampling actives (Table 5). All observations were visual. Wildlife habitat on Lake Napa Suwe is above average for a Lake County lake. The lake had healthy populations of mature trees and large expanses of shrubs that provide good habitat for a variety of birds and mammals. Additionally, the two wooded islands provided a refuge for local and migrating wildlife. The dominant shoreline type at Lake NaPaSuWe is wetlands, which provide good habitat for a variety of

Figure 13. Shoreline erosion on Lake NaPaSuWe, 2009.



wildlife. Staff frequently observed great blue herons, great egrets, and cormorants. Additionally, LMU staff sighted several small mammals including mink, muskrat, and beaver. One area of concern is the overwhelming presence of invasive species along the shores of Lake NaPaSuWe. The exotic, nuisance species: purple loosestrife, common buckthorn, and reed canary grass were found along 76% of the shoreline in 2002. These exotic weeds are seldom used by wildlife for food or shelter. These nuisance species should be controlled or eliminated before they spread and become more established displacing more desirable native species such as blue flag iris. Additionally, shoreline habitat should be improved after their removal and include the use of buffer strips to create more naturalized shoreline areas and protect against erosion.

Past IDNR reports found the fishery of Lake Napa Suwe to contain largemouth bass, bluegill, green sunfish, bullheads, carp, and several minnow species. However, these reports go on to state that due to the shallow depth of the lake it is more than likely dominated by species tolerant to low DO conditions, such as carp. LMU observations in 2002 and 2009 confirm that carp are overly abundant. Carp can cause a variety of water quality problems including resuspension of sediment and nutrients, disruption of the aquatic plant community, and low DO conditions.

LAKE MANAGEMENT RECOMMENDATIONS

Lake NaPaSuWe has changed substantially since 2002. The water quality has improved but still many parameters remain above county medians. The primary landuse within the watershed of agricultural has been developed into residential areas, and the aquatic plant community has advanced from *non-existent* to excessive densities that cover 99% of the lake bottom. Lake NaPaSuWe provided above average habitat in Lake County for local and migrating wildlife. To improve the overall quality of Lake NaPaSuWe, the LMU has the following recommendations:

Aquatic Pant Management

A key to a healthy lake is a well-balanced aquatic plant population. Aquatic plants compete with algae for nutrients and stabilize bottom substrate, which in turn improves water clarity. Putting together a good aquatic plant management plan should not be rushed. The plan should be based on the management goals of the lake and involve usage issues, habitat maintenance/restoration, and limitations of the lake. Follow up is critical for an aquatic plant management plan to achieve long-term success. A good aquatic plant management plan considers both the short and long-term needs of the lake (Appendix D1). Eurasian Watermilfoil and Curlyleaf Pondweed were exotic plants present in 2002 and 2009. Exotics compete with native plants, eventually crowding them out, providing little or poor natural diversity in addition to limited uses by wildlife. If any type of plant management is considered, it should target the exotic, invasive plant species (Appendix D2). In addition several exotic shoreline plants were found in abundance in 2002 and 2009.

Lakes with Shoreline Erosion

All of the eroded areas should be remediated to prevent additional loss of shoreline and prevent continued degradation of the water quality through sediment inputs. When possible, the shorelines should be repaired using natural vegetation instead of riprap or seawalls. Based on the 2009 assessment, there was a significant increase in shoreline erosion from 14% to 23% of the shoreline having some degree of erosion. Overall, 18% of the shoreline had slight erosion, 4% had moderate erosion, and 1% had severe erosion. The areas of moderate and severe erosion should be addressed soon. It is much easier and less costly to mitigate slightly eroding shorelines than those with more severe erosion (Appendix D3).

Assess Your Lake's Fishery

At this time little information about the fishery in Lake Napa Suwe is known. A formal fisheries assessment should be conducted to determine the diversity and health of the fish community (Appendix D6).

Options for Nuisance Algae Management

Algae blooms were common in Lake NapaSuWe; algae, is free floating and buoyant which enables the plant to take advantage of the excessive nutrients resulting in over abundance.

Without a healthy and diverse aquatic plant community to compete for nutrients the frequency and abundance of algal blooms will likely increase (Appendix D7).

- **<u>Proper Disposal of Unused and Expired Medication</u>**

  Wastewater treatment plants and septic systems are generally not designed to treat pharmaceutical waste and this practice has led to medications being found in surface and ground water, both of which are sources of drinking water. Research has shown that trace amounts of pharmaceuticals and personal care products (PPCPs) can cause ecological harm. If you have unused PPCPs you should save them for an IEPA-sponsored household hazardous waste collection (Appendix D7).

- **<u>Become a Member of Illinois Lakes Management Association</u>**

  It is recommended that the Hollow Property Owners Association become a member of Illinois Lake Management Association (ILMA). ILMA is a group of professional and citizens with interests in lakes management. There is an annual conference where ideas are exchanged and questions can be answered. In addition, you will receive a membership directory with contact information if you have questions between conferences.

- **<u>Grant program opportunities</u>**

  There are opportunities to receive grants to help accomplish some of the management recommendations listed above (Appendix F).